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AUTHOR Liu, Min; Reed, W. Michael
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ABSTRACT

Different learning strategies that are used by field-independent (FI) and field-dependent (FD) people in a hypermedia-assisted instructional setting were studied with 63 international college students for whom English was a second language. The treatment was a semantic network-based hypermedia-assisted language-learning environment to help non-native speakers of English learn vocabulary. Field dependence and independence were determined using the Group Embedded Figures Test. Patterns of learning while using the hypermedia were studied. FI and FD students employed different learning strategies. The FD students spent more time using the courseware and used it more often than did the FI subjects. The video format was a favorable medium for the FD participants, although not much difference was found in accessing the textual and graphic media among FD and FI participants. FD learners were more likely to use features that represented the wholeness of the content, while FI users tended to use component features. Hypermedia offers promise in finding ways to match instruction-type to learning style. Five tables and two figures present study findings. (Contains 27 references.) (SLD)

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THE RELATIONSHIP BETWEEN THE LEARNING STRATEGIES AND LEARNING STYLES IN A HYPERMEDIA ENVIRONMENT

MIN LIU
The University of Texas at Austin
&
W. MICHAEL REED
West Virginia University

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Correspondence sent to:

Min Liu
Department of Curriculum and Instruction
College of Education
The University of Texas at Austin
Austin, TX, 78712
(512) - 471 - 5211

RUNNING HEAD: HYPERMEDIA AND LEARNING STYLES

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RESEARCH FRAMEWORK

The study of individual differences in cognition and their impact on learning and instruction has long been a focus in cognitive psychology and education. Much research has been conducted to investigate the relationship between individuals and their ways of learning. As a result, there exists a number of learning style constructs. Witkin's field-independence/dependence theory is one of the most extensively studied and most relevant to the field of second language learning (Brown, 1987). Field-independent/dependent learning styles is, therefore, the focus of the present study.

Witkin, Moore, Goodenough, and Cox (1977) have defined field independence and field dependence as "the extent to which a person perceives part of a field as discrete from the surrounding field as a whole, rather than embedded in the field; or . . . the extent to which the person perceives analytically" (p.7). The word "field" can be a set of thoughts, ideas, or feelings. A field-independent (FI) person tends to approach a problem analytically. He or she is able to perceive a particular and relevant item in a field of distracting items. On the other hand, a field-dependent (FD) person tends to approach a problem in a more global way. He or she is capable of perceiving the total picture in a situation. A FD person is more sensitive to social cues and interested in interacting with other people; whereas a FI person tends to have a more impersonal orientation (Witkin, Moore, Goodenough, & Cox). The term field-mixed (FM) is sometimes used to refer to people who do not have such clear orientation as FD or FI, but rather fall in the middle of the continuum of FD and FI.

The practical implications of field-independent/dependent learning styles for education has indicated that the individuals' different learning styles bear direct impact upon their achievement performance. Many studies have shown that field-independent people tend to outperform field-dependent people in various settings. In investigating learning styles on study technique, Annis (1979) found that FD students did not score as well as FI students in completing items of high structural importance even when the passage was well organized. The finding implies that explicit structural support may be necessary to FD students in identifying important information. This result was supported by a study Moore and Dwyer conducted (1992), which examined the effect of B&W and color coding of information had on the achievement of FD and FI students in accomplishing visual and verbal oriented tests. It was found that FI students, on the whole, scored significantly higher than the FD students in both the visually oriented tests such as drawing and identification tests, and the verbally oriented tests such as terminology and comprehension tests. The finding also indicated that for students who received only the B&W coded treatments, FI students performed significantly better than the FD students. However, no significant differences were found among FD and FI students when the treatments were color coded. The results showed that external support can be important for FD people in processing information. Other studies provided similar results (Davey, 1989; Drane, Halpin, Halpin, VonEschenbach, & Worden, 1989; Guster, 1986; Martin & Bender, 1985; Ronning, McCurdy, & Ballinger, 1984; Williams, 1985). On the other hand, field-dependent people were found to be better at learning and remembering materials with a social content (Crutchfield, Woodworth, & Albrecht, 1958; Ruble & Nakamura, 1972). Field-dependent people were also found to benefit more from the video modeling than field-independent people in a study examining the acquisition of a teaching skill from written and video-modeling procedures (Koran, Snow, & McDonald, 1971).

While research on the effect of field-independent/dependent learning styles on achievement performance is not always consistent, numerous studies have shown that FI and FD people do learn differently. Meng and Patty (1991) conducted a study on evaluating the effectiveness of contextual organizers for field-independent/dependent subjects in computer-assisted instruction. They found that advance organizers were more effective for FD subjects, and that post-organizers were more effective for Field-Mixed (FM) subjects. In a study by Abraham (1985), it was found that FI subjects performed better with the deductive lesson whereas FD subjects performed better with the example approach. Similarly, the mapping technique was found to be more beneficial for FI subjects and the outlining technique was more effective for FD subjects (Lipsky, 1989). Other studies also confirmed that one instructional method suitable for FI learners may not necessarily be beneficial for the FD learners (Kiewra & Frank, 1986; Stansfield & Hansen, 1983). Learners with different learning styles pursue quite different ways of learning.

The relationship between computer-assisted-instruction (CAI) and learning styles has also been investigated (Emihovich & Miller, 1988; Hettinger, 1988; Rowland & Stuessy, 1988). Both Gregorc (1979) and Cosky (1980) discussed the importance of learning styles and CAI. One of the most recent developments in computer technology is the technology of hypermedia. It refers to an associative, nonlinear information presentation and representation system built around a network of multimedia materials such as text, graphics, sound, animation, and motion. How learning styles relates to Hypermedia has, recently, prompted tremendous interest in educators because accommodating learners' different needs is one of the promises hypermedia technology is believed to hold. As a new research area, whether hypermedia can fulfill this promise remains to be explored and studied. This present study is an attempt to understand the relationship between hypermedia-assisted-instruction and learners' different learning styles.

PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The purpose of this study was to investigate the different learning strategies by FI people and FD people in a hypermedia-assisted-instructional setting. The research questions were (a) what is the relationship of learners' learning styles and their patterns of learning as reflected in a hypermedia-assisted-instructional setting? and (b) which type of media, tools, and learning aids are most preferred by the different learning style groups?

DESIGN OF THE STUDY

Sample

The subjects ($N = 63$) were college, international students of various majors at a mid-Atlantic university. They were studying English in the Intensive English Program before beginning their regular undergraduate or graduate courses, because their English levels, according to their TOEFL or Michigan Test scores, have not met the minimum requirement (TOEFL = 550) for entering formal degree programs. The population of international students was selected as the sample of the study since the content area of the hypermedia environment used in the study was learning English as a second language. None of these participants had any experience with hypermedia, and most of them had not used Macintosh computers. Yet, these participants shared the common ground of improving their English proficiency.

Independent Variables

Treatment. The treatment was a semantic-network-based, Hypermedia-assisted language learning environment for non-native English speakers to learn vocabulary. Voyager's *Citizen Kane* videodisc was chosen as the context of teaching, and *HyperCard* authoring language was used to create the Hypermedia-Assisted-Vocabulary-Learning-Courseware (HAVLC).

This Hypermedia-Assisted-Vocabulary-Learning-Courseware had a theoretical framework based upon Craik and Lockhart's levels of processing theory and Rumelhart and Norman's modes of learning theory. According to these theories, information is processed at different levels. In order to retain information in the long-term memory, information needs to be processed at a deeper level. Meaningful connections need to be established between the existing knowledge structure and newly acquired information. Because of its nonlinear, associative, and flexible characteristics, hypermedia technology is perceived to have the potential of providing a computerized tool for representing human knowledge acquisition. Using hypermedia technology, this Hypermedia-Assisted-Vocabulary-Learning-Courseware immersed learners in an enriched multidimensional cultural context through the movie *Citizen Kane* while providing focus on the linguistic attributes of the target vocabulary. It incorporated text, sound, graphics and video information in the courseware and provided linkage between specific vocabulary and the corresponding movie context. The emphasis for learning was not only on the understanding of English vocabulary but also on the meaningful use of the vocabulary in proper context.

The entire courseware consisted of four subprograms, each concentrating on one part of Kane's life. Each of the four subprograms taught 20 English vocabulary with a total of 80 words in the courseware. When the movie was shown, the text of the movie was also presented on the screen, with the words taught highlighted. A click on each of these 80 highlighted word provided a learner with the options of definition, part of speech, sentence examples, video context and relationship of the word to other words (the learning

aids) presented in a network format. The definition option provided the definition of the word like that in a traditional dictionary. Graphic definitions were provided for some of the vocabulary. The part of speech option listed the part of speech of the word along with its definition. The sentence example option provided different sentences in which the word was used. The context for vocabulary use was provided through the video context option. The relationship option contained the information on word usage, synonyms, and antonyms. A learner could choose to look at all or some of these options. Before the learner proceeded, an electronic sheet would be given to inform the learner what options had been seen and whether he or she would like to see the other options. Not only the meaningful connections among these linguistic attributes of a word were emphasized, but also the listening, reading, and writing skills were all integrated and practised throughout the process.

During the process, a learner could click on any of the words (words not highlighted) to get its definition. In this way, the courseware could accommodate learners with different entry levels. A learner could take notes at any time and access the index tool, the map tool, and the on-line help tool at any point. These tools were provided to help alleviate the disorientation and cognitive overloading problems associated with hypermedia technology. The index tool allowed a learner to access a particular target word and jump to that word directly. The map tool displayed a map of the courseware structure with nodes and links. On-help tool provided explanations of terms and symbols used in the courseware. A learner could choose what options to see and how many times he or she wanted to see. Exercise was also available for each of the four subprograms. In short, two categories of program use were provided in the courseware: (a) accessing information holistically measured through the amount of time using the courseware, the number of times using the courseware and the use of video media; and (b) accessing information componentially measured through the use of different tools, the use of different learning aids, and the use of textual and graphic media.

Upon completion of the courseware, learners were required to take the achievement test. The courseware recorded the different media, different tools, and different learning aid options the participants had chosen to see, the time they spent in using the courseware, the number of times they used the courseware as well as the number of times they used the mini-dictionary and background information options.

Learning Styles. The Group Embedded Figures Test (GEFT; Oltman, Raskin, & Witkin, 1971) was used to classify the participants into field-independent (FI) and field-dependent (FD) groups. The score of the test ranged from 0 to 18. A score of 18 indicated high field-independence while a score of 0 reflected high field-dependent. The grouping of the participants into FI and FD learning styles was based upon the mean score (*MEAN* = 10.97) and the standard deviation (*SD* = 5.59) of the GEFT test. Those whose GEFT scores were one standard deviation below the mean were classified as FD participants (n = 14, *MEAN* = 2.43, *SD* = 1.4) , and those whose GEFT scores were one standard deviation above the mean were classified as FI participants (n = 18, *MEAN* = 17, *SD* = .77). The rest of the participants were grouped as Field-Mixed, whose GEFT scores were in between the GEFT scores of FD and FI participants (n = 31, *MEAN* = 11.32, *SD* = 2.74).

Dependent Variables

Patterns of learning. Patterns of learning were measured by (a) the total amount of time spent using the courseware; (b) the total number of times using the courseware, referring to the number of times a participant went back to the beginning of the courseware to use for the second or third times after the initial use; (c) the total number of times accessing different media including the text media, the video media and the graphics media; (d) the total number of times accessing the tools which included the index, the on-line help, the map, the notetaking, and the exercise tools; (e) the total number of times using the different learning aids provided for each of the 80 vocabulary words taught in the courseware, which referred to the definition, the part-of-speech, the sentence examples, the video context, and the relationship of the word to other words; (f) the total number of times using the mini-dictionary option (a learner could look up the definitions of any words used as a part of the main text, besides the 80 target words); and (g) the total number of times looking at the background information included in the courseware (see Table 1). These were used as the dependent variables in answering research question one.

Insert Table 1 Here

Type of assistance. In answering research question two, discrete types of media (see [c] in the previous paragraph), different types of tools (see [d] in the previous paragraph), and different types of learning aids (see [e] in the previous paragraph) used by the three learning style groups were treated as the dependent measures.

Procedure

The treatment involved approximately 10 hours over five sessions—an orientation session followed by four instructional sessions—over a five-week period. During the orientation session, an explanation and demonstration of the HAVLC was given as well as a hands-on experience. The participants were also given the GEFT test. In the following four instructional sessions, the participants went through the HAVLC courseware and learned a total of 80 vocabulary words with 20 words for each instructional session.

Analysis of the Data

To answer the research question "What is the relationship of learners' learning styles and their patterns of learning?" seven simple regression analyses were conducted with learning styles (the continuous scores) as the predictor and one of the seven measures of *patterns of learning* (see *dependent variables section above)* as the criterion for each regression analysis.

To answer the research question "Which type of media, tools and learning aids (*types of assistance*) will be most preferred by the different learning style groups?" ANOVAs were conducted. To find out *which type of media* was better suitable for different learning style groups, three one-way ANOVAs were run with learning styles (FI, FD, and FM) as the independent variable and (a) the number of times accessing the text media, (b) the number times accessing the video media, and (c) the number of times accessing the graphics media as the dependent variables respectively for each ANOVA. To find out *which type of tools* was more preferred by the different learning style groups, five one-way ANOVAs were conducted with learning styles as the independent variable and (a) the number of times accessing the index tool, (b) the number of times accessing the on-line help tool, (c) the number of times accessing the map tool, (d) the number of times accessing the notetaking tool, and (e) the number of times accessing the exercise tool as the dependent variables respectively for each ANOVA. To determine *which type of learning aids* was more preferred by the different learning style groups, five one-way ANOVAs were run with learning styles as the independent variable and (a) the number of times accessing the definition, (b) the number of times accessing the part of speech, (c) the number times accessing the sentence examples (d) the number of times accessing the video context and (e) the number of times accessing the relationship as the dependent variables respectively for each ANOVA.

RESULTS

Patterns of Learning

The regression results indicated that there was a significant negative relationship between the total number of times using the courseware and the learning styles: $r = .45$, $p < .01$, $t(62) = 3.88$, $p = < .01$, *beta* = -.14, *beta weight* = -.45 (see Table 2). Because the lower GEFT scores were classified as FD whereas the higher GEFT scores were classified as FI, this finding indicated that the FD learners used the courseware more than the FI learners. The regression results also indicated that there was a moderately significant, positive relationship between the learning styles and the total number of tools used: $r = .24$, $p = .06$, $t(62) = 1.91$, $p = .06$, *beta* = .97, *beta weight* = .24 (see Table 2). That is, FI participants used more tools in total than the FD participants. A trend that the FD group spent more time using the courseware than the FI group existed: $r = .22$, $p = .08$, $t(62) = 1.79$, $p = .08$, *beta* = -2.7, *beta weight* = -.22. However, no significant relationships were found between the learning style groups and the number of times accessing the media, the number of times accessing the learning aids, the number of times using the mini-dictionary option, and the number of times looking at the background information (see Table 2).

Insert Table 2 Here

Types of Assistance

Learning styles and the choice of media. The ANOVA results on the use of different types of media showed that the FD participants used significantly more video options than the FI or the FM learning style groups: $F(2,62)= 3.94$, $p < .05$, $MEAN_{FD} = 17.79$, $MEAN_{FM} = 9.45$, $MEAN_{FI} = 8.33$. The post hoc Fisher-test indicated that the mean scores between FD and FI was significantly different, Fisher-test = 7.39, $p < .05$, and the mean scores between FD and FM was also significantly different, Fisher-test = 6.68, $p < .05$ (see Table 3). The results also indicated that there were no significant differences in using the text and graphic media among the three learning style groups (see Table 3).

Insert Table 3 Here

Learning styles and the choice of tools. The ANOVA results on the use of different types of tools indicated that there was a trend for FI participants to use more index tools than the FD and the FM groups: $F(2,62)= 2.54$, $p =.09$, $MEAN_{FD} = 7.71$, $MEAN_{FM} = 9.45$, $MEAN_{FI} = 17.72$ (see Table 4 and Figure 1). Though the numbers were not statistically significant, it did show a wide margin of difference among the FD, FM, and FI groups. The index tool allowed the learners to select and go to any of the 20 target words in each of the four subprograms and continue from that point on. FI people tended to use the index tool more to move around the courseware, while FD and FM groups tended to follow the provided "sequence" of the courseware. For example, the FD and FM groups tended to follow the sequence of the movie, from the beginning to the end, whereas the FI participants tended to jump freely from one point to another using the index tool. Descriptively, the FM learning style group used the notetaking tool more often, though not statistically different, than the FD and FI groups: $MEAN_{FD} = 1.07$, $MEAN_{FM} = 7.26$, $MEAN_{FI} = 2.7$ (see Table 4 and Figure 1). There was not, however, much difference in accessing the on-line help tool, the map tool, and the exercise tool among the three learning style groups (see Table 4).

Insert Table 4 Here

Insert Figure 1 Here

Learning styles and the choice of learning aids. The ANOVA results on the use of different types of learning aids showed that the FM learning style group chose the sentence examples of words significantly more often than the FI and FD groups: $F(2,62)= 3.08$, $p <.05$, $MEAN_{FD} = 27$, $MEAN_{FM} = 37.26$, $MEAN_{FI} = 20.28$. The difference between the FM group and FI group, as indicated by the post hoc Fisher-test, was significant: Fisher-test=14.04, $p < .05$ (see Table 5 and Figure 2). That is, sentence examples seemed to be a more favorable option for the FM learning style group. On the other hand, a trend showed that video context seemed to be a favorable option for the FD participants: $F(2,62)= 2.2$, $p =.12$, $MEAN_{FD} = 15.14$, $MEAN_{FM} = 10.16$, $MEAN_{FI} = 6.5$ (see Table 5 and Figure 2). On the average, the FD group viewed the video context of words 8.6 more times than the FI group. The post hoc Fisher-test indicated this difference was significant: Fisher-test = 8.24, $p < .05$. A descriptive view of the results indicated that the FI group, however, chose the relationship option more often than the FD and FM learning style groups: $F(2,62)=1.72$, $p= .19$, $MEAN_{FD} = 28.38$, $MEAN_{FM} = 20.90$, $MEAN_{FI} = 34.6$. On the average, the FI group used the relationship option 6.25 more times than the FD group and 13.71 more times than the FM group, though these differences were not statistically different (see Table 5 and Figure 2).

Insert Table 5 Here

Insert Figure 2 Here

DISCUSSION

Hypermedia-Assisted-Instruction

Hypermedia, as an information presentation and representation system, possesses four major advantages: nonlinearness, associativity, flexibility, and efficiency (Liu, 1992). Unlike traditional methods of information presentation, there is no specific sequence for proceeding from one point to another in a Hypermedia environment. Learners can choose different ways to pursue the content based upon their interests and learning needs. A Hypermedia system is not only capable of linking logically and semantically related information in a network-format but is also capable of presenting the information through textual, graphic, video, and audio media. Because of these advantages, educators believe that Hypermedia holds much potential for optimizing learning. It is considered to be a potential means for meeting different needs by different learners.

The *Hypermedia-Assisted-Vocabulary-Learning Courseware* used in the treatment incorporated these four Hypermedia advantages in its design (Liu, 1992). It not only provided learners with a wealth of information through multimedia contextual materials but also focused on the linguistic features of vocabulary words. Though guidance was provided at different critical points, learners had the ultimate control of the choice of the media, the tools, the different learning aids, and how to proceed in order to meet their learning objectives.

Learning Strategies of FI/FD Participants in a Hypermedia Environment

The results of this study found that FI and FD people employed different learning strategies in a Hypermedia environment. This finding is in line with other research studies which showed that patterns of learning for FI and FD people are not quite the same (Abraham, 1985; Kiewra & Frank, 1986; Lipsky, 1989; Meng & Patty, 1991; Stansfield & Hansen, 1983).

The use of the courseware. The results showed that not only did the FD participants spend more time in using the courseware but also used the courseware more often than the FI participants. Since each occurrence using the courseware involved the watching of the video clips, this finding meant that FD participants watched more video clips than the FI group. This finding is consistent with the previous review of literature that have indicated that FD learners tend to employ a global and spectator approach to learning (Goodenough, 1976; Witkin, Moore, Goodenough, & Cox, 1977).

The use of the media and learning aids. The choice of the media indicated that video was a favorable media for the FD participants, although not much difference was found in accessing the textual and graphic media among the FI and FD participants. This was further supported by the different learning aids that the three learning style groups used: FI's chose more relationship options of the words, while FD's chose more video context options of words. The FM group chose more sentence examples of the words. This finding is consistent with the characteristics of FI and FD learners. FI learners tend to be more analytical in their information-processing, while the FD learners are more often social oriented, "accepting the 'whole' rather than breaking the whole into its components" (McCorkle & Cohen, 1988, p. 5). It is, therefore, not surprising to find that the FI participants chose the relationship option because it provided the most complete and detailed textual information on the use of a word. Such information included definition, parts of speech, sentence examples, and the relationship. FD participants, on the other hand, obtained information from a more global picture of the language use—the video context. The FM group chose the sentence examples, a learning aid that was in-between the relationship on one end and the video context on the other end. In other words, the flooding and focusing technique employed in designing the HAVLC allowed FI participants to focus their attention on details, while it also enabled FD participants to view language-use in a realistic context provided through the multimedia aspects of the courseware. This finding may also imply that video media could be an effective external support for the FD learners who are often defined as passive and in need of extra external support for their learning (Witkin, Moore, Goodenough, & Cox, 1977).

The use of the tools. It is interesting to note that FI participants used the index tool more than the FD participants. The index tool provided a learner with a means to look at a particular word without going through the usual sequence. For example, while watching the last part of the video clip, if a learner

decided to look at the sentence examples of a word that appeared earlier in the clip, he or she could click on that word via the index and jump to the beginning part of the video clip. When finishing, he or she could return to the location he or she was previously at by using the index. A logical interpretation for the FI participants' using the index tool more often is that, in an environment full of information, FI participants felt comfortable enough to jump from one point to another. That is, they were comfortable manipulating the courseware in different ways without being concerned with getting lost. They are independent of the "field." The FD participants, however, tended to follow the provided sequence of the courseware and focused their attention on the video watching.

These findings supported Brown's two hypotheses (1987) on learning styles and language learning: (a) a FI person is more appropriate for a formal classroom setting involving analysis, mastering of exercises, and other focused activities; and (b) a FD person is more likely to be successful in learning the communicative aspects of a language. These findings are especially true if the achievement performance of these 63 participants were taken into consideration. It was found that all 63 participants improved their performance significantly from pre-treatment to post-treatment (F (2, 124) = 555.53, $p < .01$; FD_{pre} = 35.5, FD_{post} = 85.86; FM_{pre} = 33.29, FM_{post} = 85.39; FI_{pre} = 26.56, FI_{post} = 84.17), but there was not a significant difference in the achievement scores among FD, FI, and FM groups (F (2,120) = .75, p = .47, see Liu, 1992). That is, although FI and FD participants employed different learning strategies in learning, they performed equally well on the achievement test. Hypermedia-assisted-instruction has the potential to accommodate learners with different learning styles (see Note 1 for an explanation of the achievement test).

The results also showed that, although there was not much difference in using the exercise tool among the three learning style groups, these groups, on the average, used the exercise tool at least one time during each instructional session. The FM group used the notetaking tool three times as often as the FI and FD groups. These findings indicated that the notetaking and exercise tools could be important. Across the three learning style groups, there did not exist any difference in accessing the on-line help tool and the map tool. Moreover, these two tools were found to be the least used: *MEAN*index = 11.43, *MEAN*help = 1.27, *MEAN*map = 1.73, *MEAN*notetaking = 4.59, *MEAN*exercise = 5.18. These findings could mean that these two tools were of less importance to the three learning style groups in this study. One group did not favor the use of the on-line help and the map tools over the other groups.

The use of mini-dictionary and background information options. Since the participants of the study were of different proficiency levels, vocabulary words used in the courseware known by some participants may not have been as familiar to other participants. A mini-dictionary option was included in the courseware to satisfy the needs of the participants with different entry levels. In watching the video clip and reading the transcript of the text, a participant could request the definitions of those words with which he or she was unfamiliar. In terms of the mini-dictionary option, there was a nonsignificant difference between the FI and FD groups, though FD participants used this option a little more than the FI participants ($MEAN_{FD}$ = 60.5, $MEAN_{FM}$ = 57.97, $MEAN_{FI}$ = 46.22). There was also not a significant difference in the use of the background information option among the three learning style groups. This finding might imply that these options were equally important for the different learning style groups, and different learning styles would not result in the different use of these options.

Holistic versus componential. It is interesting to find that FD and FI learners responded differently to program features that emphasized respectively the holistic and componential representations of information. That is, the FD learners tended to use the features such as video context that represented the wholeness of the content, whereas the FI learners were more likely to use the componential features such as the index tool and the relationship option. This finding raises further research questions such as "can hypermedia systems be usefully characterized in terms of features that allow learners to engage in either or both holistic and componential representations, if how different learners select and process such representations can be determined?"

CONCLUSION

Supporting other studies which showed that different learning strategies were employed by different learning styles, this study found that, in a Hypermedia environment, different learning style groups chose different media, different tools, and different learning aids to accomplish their learning tasks. In other words, learning styles do have an impact on learners' ways of learning. The fact that all learning styles performed equally well on the vocabulary achievement, yet approached learning quite differently, provided some evidence to the assumption that Hypermedia-assisted-instruction could fulfill its promise of accommodating learners with different needs.

How to match learners' learning styles to instruction has always been an important factor in designing the instruction. The technology of Hypermedia has offered some promise to find this match. Since this is a new research area, much more research is needed.

NOTES

Note 1:
The achievement test consisted of 80 multiple-choice items, 20 fill-in-the-blank items, and 20 sentence making items. The multiple choice questions, each worth one point, tested on the knowledge of the 80 words taught in the courseware. The fill-in-the-blank questions, each worth one point, attempted to test how well the words were used in a proper context. The sentence making part was to test whether learners could use the words properly after using the courseware. The total score for the sentence making part was the sum of the subtotals of the 20 sentences with a possible range of 0 (0X20, if a participant did not know the words for all the 20 items) to 160 (8X20, if a participant received 4 points from the two raters for all 20 items). The higher the number, the better the score. The KR(20) reliability coefficient for the achievement test comprising of multiple choice and fill-in-the-blank items was .90. The interrater reliability coefficients for the sentence making in the pretest was .88 and .92 in the posttest. Words for sentence making in the pretest were randomly selected and predetermined whereas the words for sentence making in the posttest were randomly selected by the computer during the test. Thus, they were varied from students to students.

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Table 1
Patterns of Learning as Dependent Variables and Their Descriptions

Patterns of Learning	**Descriptions**
(a) the total amount of time using the courseware	the total amount of time during which a participant used the courseware (although 10 hours were allocated for the treatment, participants could spend more or less time using the courseware depending on their interests)
(b) the total number of times using the courseware	the number of times a participant went back to the beginning of the courseware to use for the second or third times after the initial use
(c) the total number of times accessing different media	the total number of times a participant accessed the media including the text media (the definition option, the parts of speech option, the sentence examples, and the relationship option of each of the 80 words taught), the video media (the video context of each of the 80 words and video sentence examples of some of the 80 words) and the graphics media (the graphic representations of some of the 80 words taught)
(d) the total number of times accessing the tools	the total number of times a participant accessed the tools including the index, the on-line help (providing explanations of the icons used in the courseware), the map (providing the structure of the courseware, the location where a participant is currently at and what options he or she has seen), the notetaking, and the exercise (the following-up exercises) tools
(e) the total number of times using the different learning aids	the total number of times a participant used the different aids of each of the 80 words taught; learning aids included the definition, the part-of-speech, the sentence examples, the video context (video scenes from the *Citizen Kane* in which the word was used), and the relationship of the word to other words (the usage of the word and its synonyms and/or antonyms)
(f) the total number of times using the mini-dictionary option	a learner could look up the definitions of any words used as a part of the main text, besides the 80 target words; this option was included to accommodate learners' different entry levels of language proficiency
(g) the total number of times looking at the background information included in the courseware	background information referred to the additional information included in the courseware such as information on American presidential campaign, information on American newspaper

Table 2
Regression Results With Learning Styles as Predictor and Learning Strategy Measures as Criterion

Learning Strategy Measures	
(a) the total amount of time spent using the courseware	
R	.22
F	3.19 p = .08
Intercept	374.53
t-Value	1.79 p = .08
beta	-2.7
beta weight	-.22
(b) the number of times using the courseware	
R	.45
F	15.07 p < .01
Intercept	7.08
t-Value	3.88 p < .01
beta	-.14
beta weight	-.45
(c) the number of times accessing the media	
R	.009
F	.005 p = .95
Intercept	107.1
t-Value	.07 p = .95
beta	-.07
beta weight	-.009
(d) the number of times accessing the tools	
R	.24
F	3.63 p = .06
Intercept	13.59
t-Value	1.91 p = .06
beta	.97
beta weight	.24
(e) the number of times accessing the learning aids	
R	.01
F	.01 p = .92
Intercept	105.34
t-Value	.11 p = .92
beta	-.104
beta weight	-.01
(f) the number of times using the mini-dictionary option	
R	.06
F	.21 p = .65
Intercept	61.47
t-Value	.46 p = .65
beta	-.57
beta weight	-.06
(g) the number of times looking at the background information	
R	.03
F	.04 p = .83
Intercept	2.002
t-Value	.21 p = .83
beta	.01
beta weight	.03

Table 3
Means and Standard Deviations (in parentheses) of the Number of Times Accessing the Media

		different types of media			
	count	# of times use text	# of times use video	# of times use graphics	Total # use media
Learning Styles					
FD	14	93.93 (39.88)	17.79* (14.66)	1.43 (1.56)	113.1 (49.40)
Mixed	31	93.29 (44.72)	9.45 (9.90)	2.84 (2.82)	105.58 (51.16)
FI	18	90.89 (22.63)	8.33 (6.47)	3.06 (3.37)	102.28 (28.88)

* = significantly different from the FI and FM groups, $p < .05$

Table 4
Means and Standard Deviations (in parentheses) of the Number of Times Accessing the Tools

		different types of tools					
	count	# of times use index	# of times use help	# of times use map	# of times use note-taking	# of times use exercise	Total # use tools
Learning Styles							
FD	14	7.71 (11.36)	1.29 (1.2)	1.29 (1.54)	1.07 (1.59)	4.86 (2.85)	16.21 (15.3)
Mixed	31	9.45 (13.28)	1.16 (1.64)	2.03 (3.49)	7.26 (22.24)	4.94 (2.98)	24.84 (25.63)
FI	18	17.72 (17.42)	1.44 (2.43)	1.56 (2.55)	2.72 (6.08)	5.83 (2.48)	29.28 (21.84)

Table 5
Means and Standard Deviations (in parentheses) of the Number of Times Accessing the Learning Aids

		different types of learning aids				
	count use definition	# of times	# of times use parts of speech	# of times use sentence examples	# of times use video context	# of times use relationship
Learning Styles						
FD	14	33.5 (21.26)	5.07 (9.4)	27 (26.12)	15.14* (15.14)	28.36 (26.97)
Mixed	18	32.52 (27.7)	5.10 (9.07)	37.25* (25.49)	10.16 (12.14)	20.90 (25.7)
FI	14	32 (20.72)	4 (4.69)	20.28 (17.65)	6.5 (6.02)	34.61 (23.24)

* = significantly different from the FI group, $p < .05$

Figure 1. The Use of Index and Notetaking Tools by Different Learning Style Groups

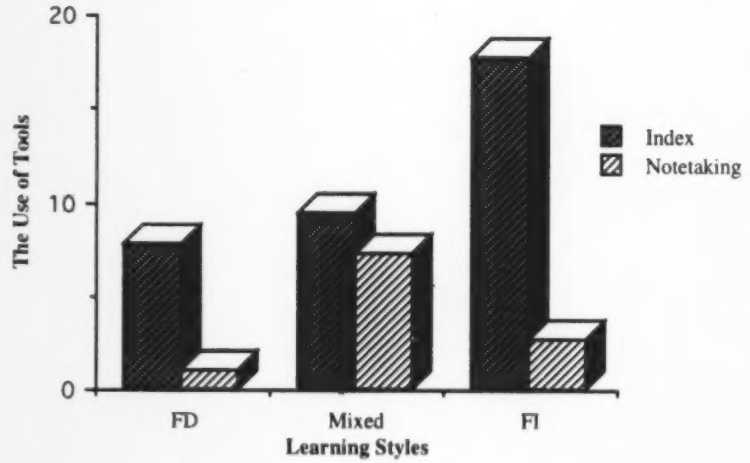

Figure 2. The Use of the Learning Aids by Different Learning Style Groups